INTEGRATED MANAGEMENT OF SEA LAMPREYS IN LAKE MICHIGAN 2007

Report to

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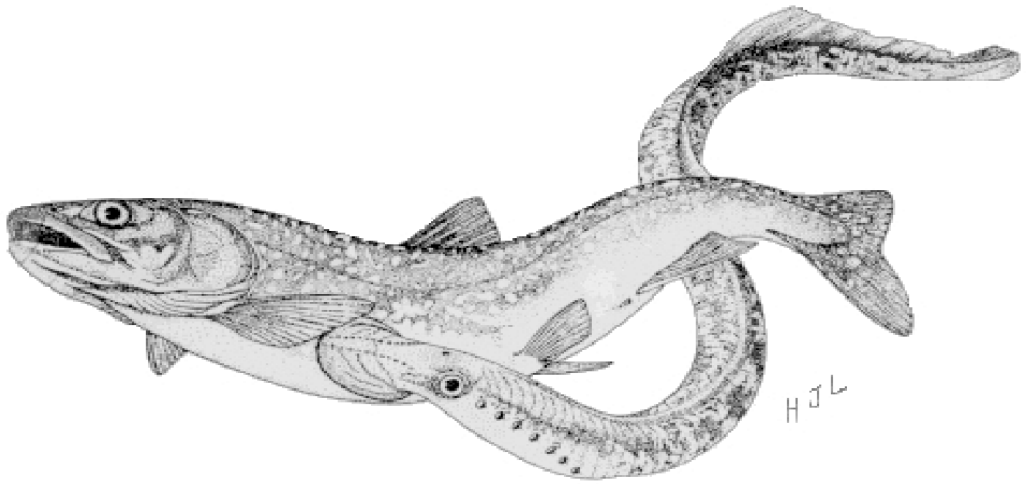

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INTRODUCTION

This report outlines the actions undertaken during 2007 by the U.S. Fish and Wildlife Service (Service) and Department of Fisheries and Oceans Canada (Department) as contract agents of the Great Lakes Fishery Commission (Commission) to manage sea lamprey (*Petromyzon marinus*) populations in the Great Lakes. The sea lamprey is an alien invasive species that causes significant damage to the Lake Michigan fish community including many commercial and sport fishes. Sea lamprey management is an important action in support of the Strategic Plan for Great Lakes Fishery Management, used to manage the diverse fisheries of Lake Michigan. The Lake Michigan Committee has established goals and targets designed to reduce sea lamprey-induced mortality to levels that will not impede the rehabilitation of lake trout (*Salvelinus namaycush*) and that will protect other valued fishes. Our report outlines the progress toward the Lake Michigan Committee's objectives, the status of larval and spawning-phase populations, and a review of activities undertaken to manage sea lamprey populations.

COMMISSION VISION

The "Strategic Vision of the Great Lakes Fishery Commission for the First Decade of the New Millennium" contains a *Vision Statement on Integrated Management of Sea Lamprey*:

The Commission will provide an integrated sea lamprey management program that supports the Fish Community Objectives for each of the Great Lakes and that is ecologically and economically sound and socially acceptable.

To achieve this vision the Commission established four milestones. The milestones and progress toward meeting the milestones are outlined below:

1) *Achieve economic injury levels*- Suppress sea lamprey populations to economic-injury levels (maximize net benefits of sea lamprey and fishery management) by the year 2005.

   Progress: Current estimates of sea lamprey numbers and marking rates are above quantitative targets established to support the Lake Committees' Fish Community Objectives. The Commission has increased the quantity and quality of control to improve suppression in all lakes.

2) *Control the St. Marys River*- Suppress the sea lamprey population in the St. Marys River to a level that allows rehabilitation of lake trout in northern Lake Huron.

Progress: The Commission and its agents are continuing an integrated control program in the St. Marys River that includes reducing sea lamprey reproduction by trapping and releasing sterile males and reducing larval populations with selective application of Bayluscide 3.2% Granular Sea Lamprey Larvicide. The observed effects since 1998 have been:

Numbers of larval sea lampreys in the river have been reduced by 52% from pre-control levels.

The number of newly metamorphosed sea lampreys migrating out of the river as measured by fyke net catch-per-unit-effort has declined by 69%.

Numbers of spawning-phase sea lampreys in Lake Huron have declined by 37%.

Wounding of lake trout in Lake Huron has declined by 63% and mortality of lake trout has declined 70%.

3) *Use alternative control techniques*- Accomplish at least 50% of sea lamprey suppression with alternative technologies while reducing TFM use by 20% through use of at least one new alternative-control method, and increased use of current methods such as sterile-male release, trapping, and barriers.

Progress: The Commission and its agents have focused on increasing the use and diversity of alternatives to lampricide treatments as part of the strategy to increase suppression of lampreys in the Great Lakes. The following progress has been made in achieving this milestone:

69 barriers and modified dams are being maintained and operated to block sea lamprey migration;

Sterile male release and trapping are major components used to control sea lampreys in the St. Marys River; and

Migratory and reproductive pheromone technologies have been brought to the field trial stage.

4) *Estimate recruitment*- Estimate recruitment of sea lampreys from all sources, including non-treated rivers, estuaries, and connecting channels by 2005.

Progress: All sources of lampreys have been inventoried but the recruitment from all sources has not been fully quantified. Surveys of streams, connecting channels, and lentic areas with the potential to produce sea lampreys continued during 2007.

FISH COMMUNITY OBJECTIVES

The Lake Michigan Committee established the following goal for sea lamprey management in its 1995 Fish Community Objectives:

Suppress the sea lamprey to allow the achievement of other fish community objectives.

Sea lamprey control has the most direct effect on achieving objectives for lake trout and other salmonines:

> *Establish a diverse salmonine community capable of sustaining an annual harvest of 2.7 to 6.8 million kilograms (6 to 15 million pounds), of which 20-25% is lake trout.*
>
> *Establish self-sustaining lake trout populations.*

Beginning in 2004, the Lake Michigan Committee agreed to explicit target numbers for sea lampreys that will support their Fish Community Objectives. The target and range were calculated from the average number of sea lampreys estimated for the 5-year period, 1988-1992, when marking rates were closest to five marks per 100 fish (4.7 A1-3 marks per 100 lake trout >21"). The lake-wide numbers of sea lampreys during that same period were estimated from a combination of mark-recapture estimates of spawning-phase migrants in streams with traps and regression model-predicted numbers in streams without traps. These model estimates are updated each year once the model is calibrated with new spawning-phase catch data. Marking rates of less than five per 100 fish were found to result in a tolerable annual rate of mortality of less than 5%, based on a relationship between marking rates and the probability of surviving a sea lamprey attack. Comparable targets for sea lamprey numbers that support the Fish Community Objectives have been calculated for the other lakes using this methodology. The calculated target abundance using all data including the 2007 spawning-phase abundance estimates was 63,000+/-12,000 sea lampreys in Lake Michigan.

During 2007, sea lamprey numbers were greater than the Fish Community Objective target for Lake Michigan. Sea lamprey numbers were estimated to be 167,125 (151,810 – 189,201, 95% confidence interval), a significant increase from 2006. Sea lamprey numbers were less than or within the target range prior to the 2000 spawning year, but have been greater than targets since the 2000 spawning year. Marking rates have trended upward, but have been greater than target levels since 1995. Marking rates increased during 2007. These marking rates may be affected by the abundance of lake trout as well as the abundance of sea lampreys.

The increasing trend in abundance since 2000 led the Commission to increase assessment and treatment effort in Lake Michigan. The causes of the increase in sea lamprey numbers are unclear, with hypotheses ranging from reduced lampricide control effort to increased survival of juvenile lampreys due to changes in the fish community. However, all known and likely sources of sea lampreys have been surveyed. Control efforts have been targeted at all potential sources of the increase in sea lampreys in Lake Michigan.

Beginning in 2001, the amount of treatment effort increased from the previous five years with special emphasis on increasing suppression in Lake Michigan. More stream treatments were carried out on Lake Michigan during 2001 – 2007 than during the previous six years. The Manistique River was treated again in 2007, following previous treatments in 2003 and 2004. Geographic efficiency was applied to expand the number of streams treated. Control crews added small streams that would not have ranked for treatment, but could be accomplished during field trips because they were located near other scheduled streams. The control agents implemented options to improve treatment effectiveness on some streams during 2007, including applying longer lampricide blocks, using higher concentrations, increasing secondary applications of lampricides to backwaters and small tributary confluences and scheduling of streams to increase

the likelihood of favorable flow conditions. Beginning in 2005, the states and tribes of Michigan and Wisconsin agreed to increased TFM concentrations in select sturgeon streams to maximize treatment effectiveness. Treatments of streams with sturgeon reproduction are still scheduled later during the year, when young sturgeons are less vulnerable.

TRIBUTARY INFORMATION

Lake Michigan has 511 tributaries. One hundred twenty-one tributaries have historical records of larval sea lamprey production, and of these, 72 tributaries have been treated with lampricides at least once during 1998-2007. Thirty-four tributaries are treated on a regular 3 - 5 year cycle.

LAMPRICIDE CONTROL

Tributaries harboring larval sea lampreys are treated periodically with lampricides to eliminate or reduce larval populations before they recruit to the lake as parasitic juveniles. Service and Department treatment units administer and monitor doses of the lampricide TFM, sometimes augmented with Bayluscide (70% Wettable Powder or 20% Emulsifiable Concentrate) to scheduled tributaries and 3.2% Granular Sea Lamprey Larvicide to scheduled lentic areas. Specialized equipment and techniques are employed to provide concentrations of lampricides that eliminate about 95% of larval sea lampreys and minimize the risk to nontarget organisms.

The following statements highlight the lampricide control program for Lake Michigan during 2007. Table 1 provides details on the application of lampricides to tributaries treated during 2007 and Fig. 1 shows the locations of the tributaries.

Treatments were successfully completed on 27 streams. Norris Creek (Grand River) was replaced on the schedule by the Black River (Allegan Co.) when a large population of large larvae and transformers were discovered during the field season. Norris Creek will be treated in 2008.

Enhanced treatment strategies to improve the efficacy of lampricide treatments were added to several treatments this year. These strategies may include: adding 10% more lampricide during the treatment; extending lampricide treatment blocks by one or two hours; using crewmembers (secondary treatment crew) to hike the course of a stream to spray backwaters with lampricides or to draw down beaver ponds. Enhanced treatment strategies were used in 15 of 27 treatments.

> The Manistique River was treated with a 50-person combined crew of U.S. and Canadian control staff. Sections of Stutts Creek, and the Driggs and Fox rivers, tributaries of the Manistique River, were treated independently to simplify the mainstream treatment.
>
> The Milakokia River, Gulliver Lake Outlet and Big Sucker Creek treatments were delayed until October due to the presence of piping plovers. Lack of access prevented treatment of some upper reaches of the Milakokia.
>
> Furlong, Hog Island, Bailey, and Beattie creeks were treated during periods of low stream discharge. The labor-intensive treatments were completed by walking the lengths of the streams and spreading TFM into isolated pools by hand. Lampricide treatment was repeated on Big Stone Creek after the initial treatment failed due to low discharge. Low water also hampered treatment of the White River.

A lentic treatment with Bayluscide 3.2% Granular Sea Lamprey Larvicide was conducted at the mouth of the Bear River (Emmet County) for the first time.

Data was collected for an invertebrate study during the Lower Platte River treatment. Pretreatment and post-treatment invertebrate samples were collected along the shoreline of the Lower Platte River to determine which species are available to be preyed upon by piping plovers.

ALTERNATIVE CONTROL

Sterile Male Release Technique

Research on the use of a sterile-male-release technique (SMRT) in sea lamprey control began during 1971. The SMRT was experimentally implemented in Lake Superior tributaries and the St. Marys River during 1991-1996, and efforts were refocused for exclusive use in the St. Marys River after 1996.

Male sea lampreys have been captured during their spawning migrations in over 25 tributaries to lakes Superior, Michigan, Huron, and Ontario for use in the SMRT. Captured males are transported to the sterilization facility at the U.S. Geological Survey Hammond Bay Biological Station. Sea lampreys are sterilized with the chemosterilant bisazir and released into the St. Marys River. Laboratory and field studies have shown that treated male sea lampreys are sterile and sexually competitive (produce mating pheromones and exhibit typical spawning behaviors). Furthermore, studies showed that in areas where sterile males were released the number of eggs hatching in nests had been reduced.

A total of 15,239 spawning-phase male sea lampreys was delivered to the sterilization facility from trapping operations on the Betsie (780), Boardman (266), Manistee (194), Manistique (10,274), Muskegon (669), Pere Marquette (131), Peshtigo (1,506), and St. Joseph (33) rivers, Carp Lake Outlet (535) and 851 from a mix of Lake Michigan tributaries.

Table 1. Details on the application of lampricides to tributaries of Lake Michigan, 2007 (Letter in parentheses corresponds to location of stream in Fig. 1).

Stream	Date	Discharge (m^3/s)	TFM (kg)[1,2]	Bayluscide (kg)[1,3]	Distance Treated (km)
Tacoosh R. (X)	May 4	0.6	106.9	0	16.1
Door Co. No. 23 Cr. (P)	May 4	0.1	12.9	0	0.5
Kewaunee R. (O)	May 6	0.2	147.2	0	3.1
Ogontz R. (Y)	May 7	0.5	95.9	0	16.1
Hibbards Cr. (Q)	May 8	0.3	97.1	0	4.7
Cedar R. (U)	May 17	4.5	1472.4	3.3	101.4
Bark R. (V)	May 21	0.4	238.9	0	37.0
Millecoquins R. (CC)	May 31	2.0	32.1	0	40.3
Bear R. (D)	Jun 5	--	0	9.43	--
Jordan R. (E)	Jun 6	5.7	1278.69	23.3	29.0
Kalamazoo R. (L)					
Mann Cr.	Jun 27	0.1	19.0	0	1.6
Hog Island Cr. (A)	Jun 28	0.1	19.2	13.6	3.2
Grand R. (K)					
Sand Cr.	Jun 28	0.5	184.12	0	12.9
Menominee R. (R)	Jun 28	--	0	15.2	--
Pentwater R. (I)	Jul 1	1.5	544.6	0	31.2
Good Harbor Cr. (G)	Jul 26	0.3	127.1	0	4.5
Days R. (W)	Aug 9	0.1	79.7	0	6.9
Beattie Cr. (S)	Aug 12	0.1	2.2	0	1.8
Bailey Cr. (T)	Aug 13	0.1	2.2	0	1.3
White R. (J)	Aug 13	9.8	1811.5	20.1	129.0
Platte R. (H)	Aug 23	8.7	452.1	8.7	35.3
Monroe Cr. (F)	Sep 9	0.1	36.3	0	1.6
Manistique R. (Z)	Sep 20	34.0	3323.9	16.5	450.8
Black R. (M)	Oct 4	0.9	220.8	0	35.7
Galien R. (N)	Oct 8	0.9	273.8	0	29.1
Big Stone Cr. (B)	Oct 18	0.2	25.7	0	1.6
Big Sucker Cr. (C)	Oct 19	0.7	103.0	0	4.8
Gulliver Lake Outlet (AA)	Oct 21	0.5	108.5	0	2.6
Milakokia River (BB)	Oct 22	3.4	543.4	0	25.1
Grand Total		**76.3**	**11,359.2**	**110.1**	**1,027.2**

[1]Lampricide quantities are reported in kg of active ingredient.
[2]Includes 377 TFM bars (78.7 kg active ingredient) applied in 12 streams.
[3]Includes Bayluscide 3.2% Granular Sea Lamprey Larvicide applied in spot treatments or to lentic areas.

Figure 1. Locations of Lake Michigan tributaries treated with lampricides (corresponding letters in Table 1) during 2007.

Barriers

A review of the sea lamprey barrier program during 2007 established the following priorities:

1.) Operate and maintain existing Commission sea lamprey barriers.
2.) Ensure sea lampreys are blocked at important or desired de facto barrier sites.
3.) Construct new structures in streams where they:
   a. provide control where other options are impossible, excessively expensive, or ineffective;
   b. provide a cost-effective alternative to lampricide control;
   c. improve cost-effective control in conjunction with pheromone-based control methods; trapping, the sterile male program, and lampricide treatments; and
   d. are compatible with a system's watershed plan.

Presently, there are 12 sea lamprey barriers on Lake Michigan (Fig. 2).

Operation and Maintenance of Existing Barriers

Pere Marquette - The electric barrier was operated from March 1 through July 31. The fishway was operated seven days per week from March 2 through June 22 and during weekdays from June 23 through July 31. The fishway passed 7,725 steelhead, 41,882 suckers, 83 brown trout, and 9 Chinook salmon.

Jordan River - The electric barrier was not operated during 2007 because it was not effectively blocking sea lampreys.

USFWS personnel conducted spring start-up inspections on six barriers to ensure that all gates and stop-logs were in place prior to lamprey migrations.

USFWS personnel performed routine maintenance and safety inspections on eight barriers.

Ensured Blockage at Other Barriers

Thompson Creek – The Michigan Department of Natural Resources (MDNR) and Marquette Biological Station (MBS) continue coordination efforts to remove a series of dams at the Thompson State Fish Hatchery. MBS staff determined that removal of these dams may affect sea lamprey control efforts.

Little Calumet Creek– The Indiana Department of Environmental Management and the USFWS Green Bay National Fish and Wildlife Conservation Office (USFWS - GBNFWCO) are coordinating with MBS on a fish passage project at the sea lamprey barrier.

Bark Creek (Grand River) – The USFWS - GBNFWCO consulted with MBS to replace a culvert at State Road. MBS staff determined that replacement would not affect sea lamprey control efforts.

Castle Creek (Grand River) - The USFWS - GBNFWCO consulted with MBS to replace a culvert at Hayes Street. MBS staff determined that replacement would not affect sea lamprey control efforts.

Greene River (Jordan River) – The USFWS-GBNFWCO, MDNR, and MBS completed efforts to remove the dam on this tributary.

Boardman River – The Boardman River Dams Settlement Agreement Implementation Team and MBS continue coordination efforts with several upstream dam removal projects and a lake sturgeon fish passage project at the Union Street dam. MBS staff determined that the upstream dam removals would not affect sea lamprey control efforts, but that any modification to the Union Street dam must include plans to ensure that the structure remains a sea lamprey barrier.

Stover Creek – MBS completed a culvert removal project with the Irish Boat Shop, owner of a dam located near the mouth, ensuring that the dam structure remains a sea lamprey barrier.

Antrim Creek (Jordan River) – The USFWS-GBNFWCO and MBS continue coordination efforts to remove a dam on this tributary. MBS staff determined that removal would not affect sea lamprey control efforts.

Dair Creek (Betsie River) – The MDNR and MBS continue coordination efforts to remove a dam on this tributary. MBS staff determined that removal would not affect sea lamprey control efforts.

New Construction

New barrier projects were in various stages of planning for Trail Creek and the Manistique River.

The Cedar and South Branch Galien River barrier projects were terminated.

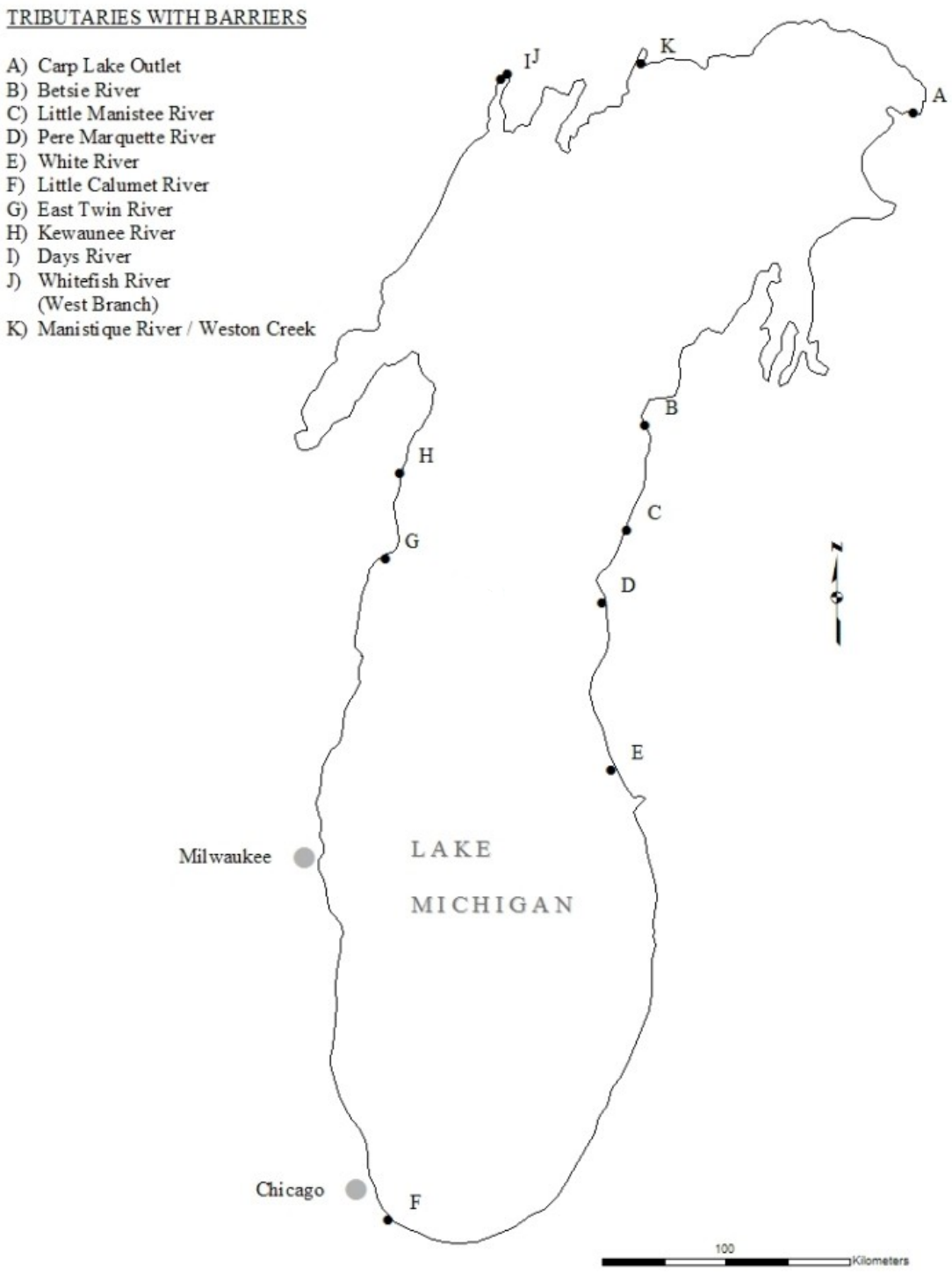

Figure 2. Locations of Lake Michigan tributaries with sea lamprey barriers.

ASSESSMENT

Larval

Tributaries to the Great Lakes are systematically assessed for abundance and distribution of larval sea lampreys. Quantitative estimates of metamorphosing sea lampreys are used to prioritize streams for lampricide treatment. Qualitative sampling is used to define the distribution of sea lampreys within a stream and to establish the sites for lampricide application. Lentic areas are monitored for abundance and distribution of larvae in deepwater areas.

Tributaries considered for lampricide treatment during 2008 were assessed during 2007 to estimate larval sea lamprey density and amount of suitable larval habitat. Assessments were conducted with backpack electrofishers in waters <1m deep. Waters >1m in depth were surveyed with deepwater electrofishers or Bayluscide 3.2% Granular Sea Lamprey Larvicide. Survey plots were randomly selected in each tributary, catches of larvae were adjusted for gear efficiency, and lengths were standardized to the end of the growing season. Larval populations in each tributary were estimated by multiplying the mean density of larvae (number per m^2) by an estimated area of suitable habitat (m^2). The proportion of metamorphosing larvae during 2008 was developed from historical relations of the proportion of metamorphosed to larval sea lampreys collected during previous lampricide applications. Tributaries were ranked for treatment during 2008 based on an estimated cost per kill of metamorphosed sea lampreys.

Assessments of sea lamprey larvae were conducted in 83 tributaries and offshore of 12 tributaries. Tables 2 and 3 present the status of larval sea lamprey populations in streams and lentic areas with a history of sea lamprey production.

Larval populations were estimated in 23 tributaries for potential lampricide treatment during 2008 (Table 2).

Post-treatment assessments were conducted in 18 tributaries to determine the effectiveness of lampricide treatments during 2006 and 2007.

Assessments to detect the presence of new sea lamprey populations were conducted in 1 tributary along the east shore and 10 tributaries along the west shore. No new populations were found.

Paired quantitative assessment and catch-per-unit-effort sampling methods were conducted cooperatively with researchers from Michigan State University (MSU) in 13 tributaries as part of a larger project to test a potentially more efficient sampling method for selecting streams for lampricide application. Personnel from the Marquette and Ludington Biological stations participated in mark recapture estimates of larval sea lamprey populations in the Bark River and Sand Creek (Grand River). Results of these studies were used by researchers from MSU to evaluate which larval assessment sampling methodology results in the most cost-effective method of ranking streams for lampricide application.

Larval sea lampreys were collected from one tributary for ongoing migratory pheromone research being conducted by MSU.

Table 2. Status of larval sea lampreys in Lake Michigan tributaries with a history of sea lamprey production, and estimates of abundance from tributaries surveyed during 2007.

Tributary	Last Treated	Last Treated	Status of larval lamprey population (most recent survey since treatment)		Estimate of 2007 Larval Population	2008 Metamorphosing Estimate	Proposed Next Treatment Year
			Residuals present	Recruitment evident			
Brevort R. (Lower)	Oct-06	Aug-06	---	---	---	---	2010
Brevort R. (Upper)	Oct-87	Aug-07	---	Yes	10,655	2	***2008***
Paquin Cr.	Oct-87	Oct-07	---	Yes	---	---	Unknown
Davenport Cr.	Aug-63	May-07	---	Yes	---	---	Unknown
Hog Island Cr.	Jul-07	May-07	---	---	---	---	2010
Sucker R.	Jun-61	May-07	---	Yes	---	---	Unknown
Black R.	Jun-06	Oct-06	Yes	Yes	3,377	7	2009
Mile Cr.	Sep-72	Oct-07	---	Yes	117	0	Unknown
Millecoquins R.							
Upper	Jun-07	May-07	---	---	---	---	2011
McAlpine Cr.	Jun-07	Oct-06	---	---	---	---	2011
Furlong Cr.	Jun-07	Jul-06	---	---	---	---	2011
Rock R.	May-06	Sep-06	No	Yes	---	---	Unknown
Crow R.	May-06	Sep-06	No	Yes	---	---	Unknown
Cataract R.	Aug-04	Oct-07	Yes	Yes	1005	1	Unknown
Pt. Patterson Cr.	Sep-83	May-06	---	No	---	---	Unknown
Hudson Cr.	May-98	Oct-07	---	Yes	---	---	***2008***
Swan Cr.	Jul-92	May-07	No	No	---	---	Unknown
Seiners Cr.	May-84	May-07	No	No	---	---	Unknown
Milakokia R.	Oct-07	Sep-07	---	---	---	---	2012
Bulldog Cr.	Jun-97	Jul-07	---	Yes	540	10	***2008***
Gulliver Lake Outlet	Oct-07	May-07	---	---	---	---	Unknown
Marblehead Cr.	May-05	Jun-04	---	---	---	---	2009
Manistique R.							
Above Dam	Sep-07	Jul-07	---	---	---	---	Unknown
Below Dam	Sep-07	Sep-06	---	---	---	---	Unknown
Estuary	Sep-07	Sep-06	---	---	---	---	Unknown
Southtown Cr.	Jun-77	Jun-06	---	Yes	---	---	Unknown
Thompson Cr.	Never	Jul-07	N/A	Yes	---	---	Unknown
Johnson Cr.	Aug-81	Jul-07	---	Yes	35	0	Unknown
Deadhorse Cr.	Jul-04	Jul-07	---	Yes	701	1	Unknown
Gierke Cr.	Never	May-07	N/A	Yes	---	---	Unknown
Bursaw Cr.	Jul-04	Sep-07	Yes	Yes	1,133	14	***2008***
Parent Cr.	Jun-91	Sep-07	---	Yes	172	5	Unknown
Poodle Pete Cr.	Aug-01	Jun-05	No	No	---	---	Unknown
Valentine Cr.	Jun-97	Sep-07	---	Yes	15,830	191	***2008***
Little Fishdam R.	May-01	May-07	No	No	---	---	Unknown
Big Fishdam R.	Aug-04	Sep-07	Yes	Yes	23,461	761	***2008***
Sturgeon R.	Jun-03	Oct-07	Yes	Yes	---	---	***2008***
Ogontz R.	May-07	Oct-07	No	Yes	---	---	2011
Squaw Cr.	Aug-00	May-07	No	No	---	---	Unknown
Hock Cr.	May-81	Sep-06	---	No	---	---	Unknown
Whitefish R.	May-06	Sep-07	Yes	Yes	176,895	12,547	***2008***
Rapid R.	May-06	Sep-06	No	---	---	---	2009
Tacoosh R.	May-07	Oct-07	No	---	---	---	2011
Days R.	Aug-07	Jul-07	---	---	---	---	***2008***
Portage Cr.	Sep-05	May-07	---	Yes	---	---	Unknown
Ford R.	Jun-05	Oct-07	Yes	Yes	---	---	***2008***
Sunnybrook Cr.	May-71	May-05	---	No	---	---	Unknown
Bark R.	May-07	Oct-07	No	No	---	---	Unknown
Cedar R.	May-07	Oct-07	Yes	Yes	---	---	2010
Sugar Cr.	Aug-77	Aug-07	---	Yes	523	25	***2008***
Arthur Bay Cr.	Apr-70	May-05	---	No	---	---	Unknown

Table 2. continued

Tributary	Last Treated	Last Treated	Status of larval lamprey population (most recent survey since treatment)		Estimate of 2007 Larval Population	2008 Metamorphosing Estimate	Proposed Next Treatment Year
			Residuals present	Recruitment evident			
Rochereau Cr.	Apr-63	May-07	---	No	---	---	Unknown
Johnson Cr.	Apr-63	May-07	---	Yes	---	---	Unknown
Bailey Cr.	Aug-07	Sep-07	Yes	---	---	---	Unknown
Beattie Cr.	Aug-07	Sep-07	Yes	---	---	---	Unknown
Springer Cr.	May-99	Aug-07	No	Yes	785	12	***2008***
Menominee R.	Jun-07	Sep-06	---	---	---	---	Unknown
Little R.	Aug-87	Sep-04	---	No	---	---	Unknown
Peshtigo R.	Oct-06	Aug-07	No	Yes	---	---	2009
Oconto R.	Jul-05	Oct-07	Yes	Yes	26,259	828	***2008***
Pensaukee R.	Nov-77	Aug-06	---	No	---	---	Unknown
Suamico R.	Never	Sep-05	N/A	No	---	---	Unknown
Ephraim Cr.	Apr-63	May-03	---	No	---	---	Unknown
Hibbards Cr.	May-07	Sep-07	No	No	---	---	Unknown
Whitefish Bay Cr.	May-87	Oct-07	---	Yes	---	---	Unknown
Lilly Bay Cr.	Apr-63	May-07	---	No	---	---	Unknown
Bear Cr.	May-75	May-07	---	No	---	---	Unknown
Door Co. 23 Cr.	May-07	May-07	---	---	---	---	Unknown
Ahnapee R.	Apr-64	Sep-04	---	No	---	---	Unknown
Three Mile Cr.	May-75	Sep-07	---	Yes	---	---	***2008***
Kewaunee R.(Casco Cr.)	May-07	May-07	---	---	---	---	Unknown
East Twin R.	Jun-04	Aug-07	---	---	---	---	***2008***
Fischer Cr.	May-87	Sep-04	---	No	---	---	Unknown
Carp Lake R.	Oct-04	Oct-07	Yes	Yes	---	---	***2008***
Big Stone Cr.	Oct-07	Oct-07	Yes	---	---	---	Unknown
Big Sucker R.	Oct-07	Oct-07	Yes	---	---	---	Unknown
Wycamp Lake Outlet	May-00	Oct-07	---	Yes	---	---	***2008***
Horton Cr.	Oct-04	Jul-06	No	Yes	---	---	Unknown
Boyne R.	May-06	Jul-06	Yes	---	---	---	2009
Porter Cr.	Oct-04	Jul-06	Yes	Yes	---	---	Unknown
Jordan R.	Sep-07	Oct-07	Yes	---	---	---	2011
Monroe Cr.	Sep-07	Oct-07	No	No	---	---	2011
Loeb Cr.	Oct-04	Aug-07	No	Yes	---	---	***2008***
McGeach Cr.	Oct-99	Jun-05	No	No	---	---	Unknown
Elk Lake Outlet	Sep-04	Aug-07	No	Yes	271	2	Unknown
Yuba Cr.	May-06	Jun-06	No	---	---	---	Unknown
Acme Cr.	Aug-63	Jun-06	---	No	---	---	Unknown
Mitchell Cr.	Sep-03	Aug-07	Yes	Yes	5,147	87	***2008***
Boardman R.	May-06	May-06	No	---	---	---	2009
Leo Cr.	Never	May-07	N/A	No	---	---	Unknown
Goodharbor Cr.	Jul-07	Aug-07	No	---	---	---	2011
Crystal R.	Oct-72	May-04	---	No	---	---	Unknown
Platte R. (upper)	Aug-07	Oct-07	Yes	---	---	---	2011
Platte R. (middle)	Aug-07	Oct-07	No	---	---	---	2011
Platte R. (lower)	Aug-07	Oct-07	No	---	---	---	2011
Betsie R.	Sep-06	Sep-06	No	---	---	---	2010
Bowen Cr.	Never	Jul-04	N/A	No	---	---	Unknown
Big Manistee R.	Aug-06	Sep-06	Yes	---	---	---	2009
L. Manistee R.	Jul-04	Oct-07	Yes	Yes	355,331	3,461	***2008***
Gurney Cr.	Jul-05	Aug-06	Yes	No	---	---	Unknown
Cooper Cr.	Never	Sep-07	N/A	Yes	319	4	***2008***
Lincoln R.	Jul-06	Sep-06	Yes	---	---	---	2010
Pere Marquette R.	Aug-06	Oct-07	Yes	Yes	---	---	2010
Bass Lake Outlet	Aug-78	Jul-07	---	No	---	---	Unknown
Pentwater R. (North Br.)	Jun-07	Oct-07	No	Yes	---	---	2011
Lambricks Cr.	Sep-84	Jun-05	---	No	---	---	Unknown

Table 2. continued

Tributary	Last Treated	Last Treated	Status of larval lamprey population (most recent survey since treatment)		Estimate of 2007 Larval Population	2008 Metamorphosing Estimate	Proposed Next Treatment Year
			Residuals present	Recruitment evident			
Stony Cr.	Jul-87	Jun-05	---	Yes	---	---	Unknown
Flower Cr.	Sep-81	Sep-05	---	No	---	---	Unknown
White R.	Aug-07	Sep-07	Yes	---	---	---	2010
Duck Cr.	Jul-84	Jun-06	---	No	---	---	Unknown
Muskegon R.	Aug-05	Jul-07	Yes	Yes	3,040,978	12,797	***2008***
Brooks Cr.	Aug-05	Sep-07	No	No	---	---	2009
Cedar Cr.	Aug-05	Jul-07	No	No	---	---	2009
Bridgeton Cr.	Jul-04	Jun-06	No	No	---	---	***2008***
Minnie Cr.	Aug-04	Jul-07	Yes	Yes	1,356	31	***2008***
Bigelow Cr.	Aug-05	Jul-07	Yes	Yes	74,401	481	***2008***
Big Bear Cr.	Aug-70	Jun-07	---	No	---	---	Unknown
Mosquito Cr.	Sep-68	Jul-07	---	Yes	---	---	***2008***
Black Cr.	Aug-70	Oct-07	---	Yes	27,381	1,208	***2008***
Grand R.	Never	Jul-07	N/A	No	---	---	Unknown
Norris Cr.	Jun-00	Aug-07	---	Yes	1,195	744	***2008***
Lowell Cr	Sep-65	Aug-05	---	No	---	---	Unknown
Buck Cr.	Sep-65	Aug-05	---	No	---	---	Unknown
Rush Cr.	Sep-65	Aug-05	---	No	---	---	Unknown
Sand Cr.	Jun-07	Jun-07	No	Yes	---	---	2011
Crockery Cr.	Sep-04	Jun-07	No	Yes	---	---	Unknown
Bass R.	Aug-04	Jul-07	No	No	---	---	Unknown
Pigeon R.	Oct-64	Jun-07	---	No	---	---	Unknown
Pine Cr.	Oct-64	Jun-07	---	No	---	---	Unknown
Gibson Cr.	Jul-84	Jul-07	---	No	---	---	Unknown
Kalamazoo R.	Never	Jul-07	N/A	Yes	---	---	Unknown
Bear Cr.	Aug-04	Jul-07	No	No	---	---	Unknown
Sand Cr.	Aug-04	Jul-07	Yes	No	---	---	Unknown
Mann Cr.	Jun-07	Jul-07	No	No	---	---	2011
Rabbit R.	Jul-81	Jul-07	---	Yes	---	---	***2008***
Swan Cr.	Jul-77	Aug-06	No	Yes	---	---	Unknown
Allegan 3 Cr.	Sep-65	Jul-07	---	No	---	---	Unknown
Allegan 4 Cr.	Oct-78	Jun-06	---	Yes	---	---	Unknown
Allegan 5 Cr.	Never	Jul-07	N/A	No	---	---	Unknown
Black R.	Oct-07	Sep-07	---	---	---	---	Unknown
Brandywine Cr.	Oct-85	Jun-06	---	Yes	---	---	Unknown
Rogers Cr.	May-98	Jun-06	---	No	---	---	Unknown
St. Joseph R.	Never	Jul-07	N/A	No	---	---	Unknown
Lemon Cr.	Oct-65	May-03	---	No	---	---	Unknown
Pipestone Cr.	Aug-03	Jun-06	No	No	---	---	Unknown
Meadow Dr.	Oct-65	Sep-07	---	No	---	---	Unknown
Hickory Cr.	Oct-65	Sep-07	No	Yes	---	---	Unknown
Paw Paw R.	May-05	Sep-07	Yes	Yes	65,152	9,467	2009
Blue Cr.	May-01	Sep-07	No	No	---	---	Unknown
Mill Cr.	May-05	Sep-07	No	Yes	570	12	2009
Brandywine Cr.	May-05	Sep-07	No	No	---	0	2009
Brush Cr.	May-05	Sep-07	Yes	No	119	118	2009
Galien R. (N. Br.)	Oct-07	Jul-07	---	---	---	---	2011
E. Br. Galien & Dowling Cr.	Oct-07	Jul-07	---	---	---	---	2011
S. Br. Galien & Galina Cr.	Oct-05	Sep-06	Yes	---	---	---	2009
Spring Cr.	Oct-05	Jun-06	No	---	---	---	2009
South Br. Spring Cr.	Oct-05	Jun-06	No	---	---	---	2009
State Cr.	May-86	Jul-07	---	No	---	---	Unknown
Trail Cr.	Jul-06	Jul-07	No	No	---	---	2010
Donns Cr.	May-66	Jun-06	---	No	---	---	Unknown
Burns Ditch	Jul-99	Jul-07	No	No	---	---	Unknown

Table 3. Status of larval sea lampreys in historically infested lentic areas of Lake Michigan during 2007.

Stream Name	Lentic Area	Last Surveyed	Last Survey Showing Infestation	Last Treated
Brevort R.	Brevort Lake (Silver Cr. – Offshore)	Aug-07	Aug-07	Never
	Brevort Lake (L. Brevort R. – Offshore)	Aug-07	Aug-74	Never
Hog Island Cr.	Hog Island Cr. (Offshore)	Aug-06	Aug-06	Jun-07
Black R.	Black R. (Offshore)	Aug-06	Aug-06	Never[2]
Millecoquins R.	Millecoquins Lake (Cold Cr. – Offshore)	Aug-07	Aug-07	Never
Milakokia R.	Seul Choix Bay	Sep-07	Aug-80	Never
Manistique R.	Manistique R. (Offshore)	Jul-07	Jul-07	Aug-03[1]
Bursaw Cr.	Bursaw Cr. (Offshore)	Jul-86	Jul-76	Never
Ogontz R.	Ogontz R. (Offshore)	Aug-07	Aug-07	Never[2]
Whitefish R.	Big Bay De Noc	Jul-07	Jul-07	Never
Rapid R.	Little Bay De Noc	Aug-88	Jul-80	Never
Days R.	Little Bay De Noc	Jul-06	Jul-06	Never[2]
Escanaba R.	Little Bay De Noc	Aug-07	Jul-06	Never[2]
Portage Cr.	Portage Bay	Jul-84	Jul-77	Never
Ford R.	Green Bay	Jun-07	Jun-07	Never
Cedar R.	Green Bay	Aug-07	Aug-07	Never[1]
Beattie Cr.	Green Bay	Jul-85	Jul-85	Never
Menominee R.	Green Bay	Sep-06	Sep-06	Never[2]
Whitefish Bay Cr.	Whitefish Bay	Sep-06	Never	Never
Carp Lake R.	Cecil Bay	Aug-06	Aug-06	Never[2]
Bear R.	Little Traverse Bay	May-06	May-06	May-07
Horton Cr.	Horton Bay (Lake Charlevoix)	Jul-06	Jun-04	Never[2]
Boyne R.	Boyne Harbor (Lake Charlevoix)	Oct-07	Oct-07	May-06
Porter Cr.	Lake Charlevoix	Jul-06	Jul-06	Never[2]
Jordan R.	Lake Charlevoix	Jul-06	Jul-06	May-07
Monroe Cr.	Lake Charlevoix	Jul-06	Jul-06	Never[2]
Mitchell Cr.	Grand Traverse Bay (East Arm)	May-04	May-04	Never[2]
Boardman R.	Grand Traverse Bay (West Arm)	Jun-06	May-04	Never[2]
Leland R.	Leland R. (Offshore)	May-07	May-07	Never[2]
Platte R.	Loon Lake	Sep-00	Aug-96	Never
	Platte Lake	Jul-03	Jul-03	Never[2]
Betsie R.	Betsie Lake	Aug-83	Aug-83	Never[2]
Big Manistee R.	Manistee Lake	Sep-06	Aug-90	Never

[1] Scheduled for treatment during 2008.

[2] Low-density larval population monitored with Bayluscide 3.2% Granular Sea Lamprey Larvicide surveys.

Spawning-phase

The long-term effectiveness of the control program has been measured by the annual estimation of the lake-wide populations of spawning-phase sea lampreys. Traps and nets were used to capture migrating spawning-phase sea lampreys during the spring and early summer in a subset of streams with sea lamprey spawning runs. Multiple regression models are used to estimate the relationship between spawning runs and within-stream biotic and abiotic factors such as larval population abundance and stream discharge. These models are used to estimate spawning populations in streams that are not trapped. Lake-wide populations have been estimated since 1986 from a combination of mark-recapture estimates in streams with traps and model-predicted estimates in streams without traps.

A total of 39,147 sea lampreys was trapped at 16 sites in 15 tributaries during 2007 (Table 4, Fig. 3).

The estimated population of spawning-phase sea lampreys in Lake Michigan was 167,125 (99,971 north and 67,154 south; $r^2 = 0.77$), which is above the Fish Community Objective target and a significant increase from 2006 (Fig 4).

Sea lamprey numbers were below or within the target range prior to the 2000 spawning year, but showed a significant trend upward to a peak abundance of 167,126 during 2007 (Fig 4.).

Spawning runs were monitored in the Boardman and Betsie rivers through a cooperative agreement with the Grand Traverse Band of Ottawa and Chippewa Indians and in the Carp Lake Outlet with the Little Traverse Bay Bands of Odawa Indians.

Table 4. Stream name, number caught, spawner estimate, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps in tributaries of Lake Michigan during 2007 (Letter in parentheses corresponds to location of stream in Fig. 3).

Stream Name	Number caught	Spawner estimate	Trap efficiency	Number sampled[1]	Percent males	Mean length (mm)		Mean weight (g)	
						Males	Females	Males	Females
Carp Lake Outlet (B)	3,110	5,883	53	225	55	486	479	240	243
Jordan R.	---	---	---	---	---	---	---	---	---
Deer Cr. (C)	116	630	18	15	80	471	410	233	160
Boardman R. (D)	583	1,045	56	65	52	492	482	311	285
Betsie R. (E)	2,062	4,493	46	184	34	501	501	264	277
Big Manistee R. (F)	258	---	---	---	---	---	---	---	269
Little Manistee R. (G)	429	995	43	37	59	496	488	267	268
Pere Marquette R. (H)	546	888	61	53	49	516	503	288	286
Muskegon R. (I)	2,043	5,370	38	116	71	506	500	274	279
St. Joseph R. (J)	374	1,089	34	17	35	526	531	287	299
East Twin R. (K)	115	486	24	16	50	495	480	244	257
Oconto R. (L)	148	288	51	59	51	518	507	282	273
Peshtigo R. (M)	4,786	6,051	79	633	52	510	508	275	285
Menominee R. (N)	1,227	4,250	29	262	58	512	510	261	274
Ogontz R. (O)	1	---	---	---	---	---	---	---	---
Manistique R. (P)	23,211	47,289	49	475	51	512	507	279	285
Hog Island Cr. (G)	138	511	27	35	74	501	494	267	253
Total or Mean	**39,147**	**79,268**		**2,192**	**53**	**506**	**503**	**269**	**227**

[1]The number of sea lampreys from which length and weight measurements were determined.

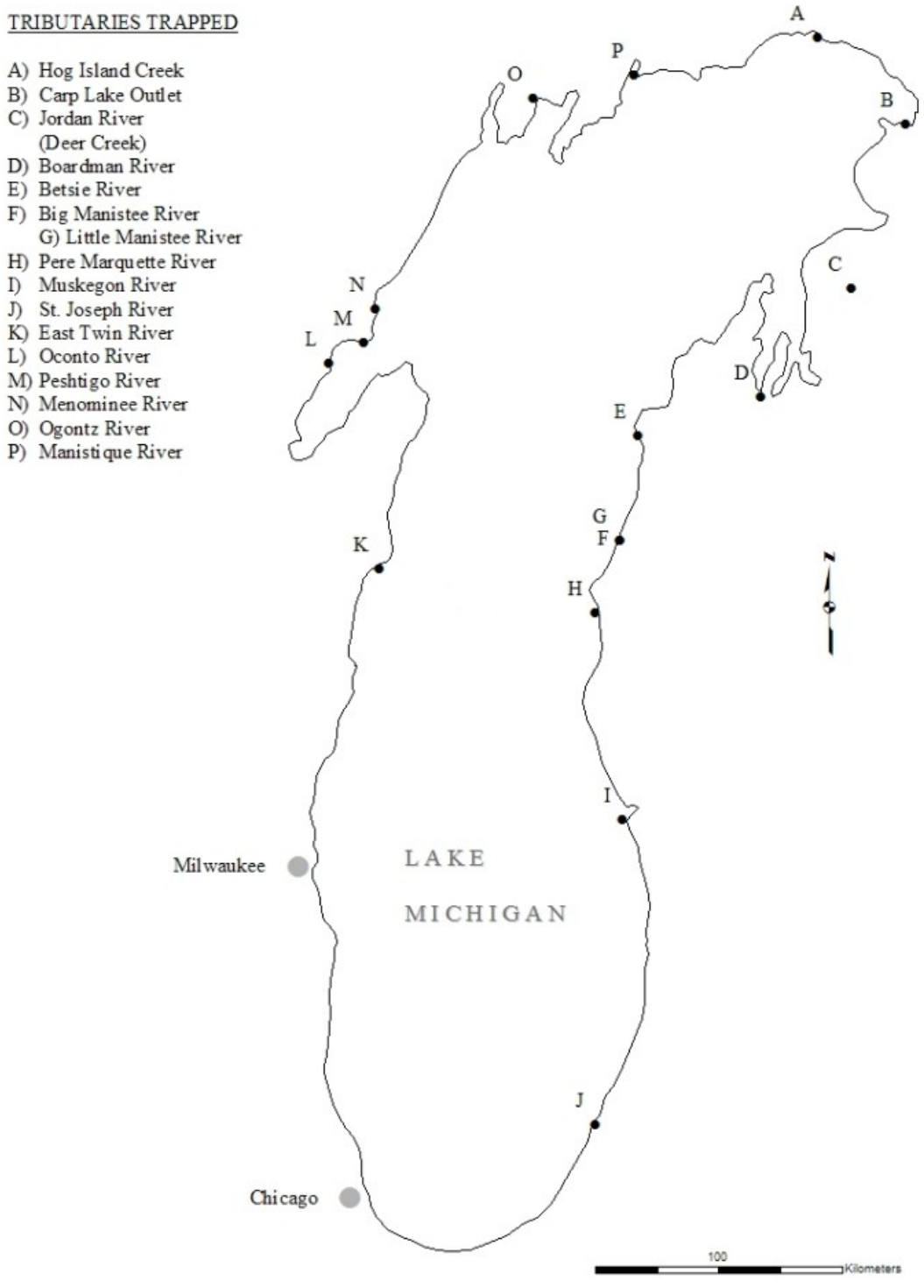

Figure 3. Locations of Lake Michigan tributaries where assessment traps were operated (corresponding letters in Table 4) during 2007

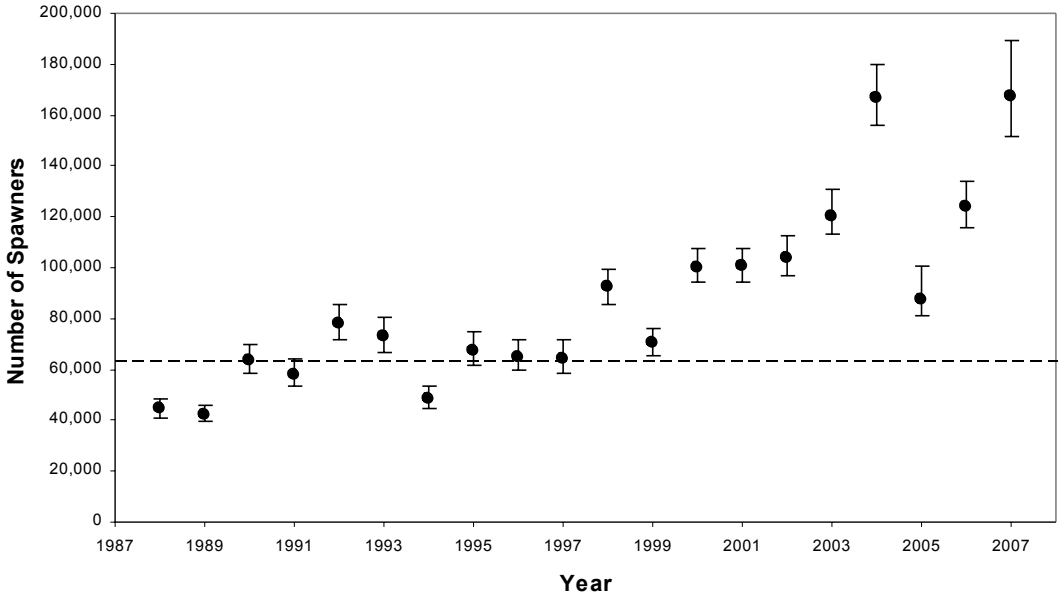

Figure 4. Annual lake-wide population estimates of spawning-phase sea lampreys in Lake Michigan during 1988 - 2007 with 95% confidence intervals (vertical lines) and target level (dashed line).

Parasitic-phase

The Michigan and Wisconsin Departments of Natural Resources provided data on the frequency of parasitic-phase sea lampreys attached to fish caught by sport charter boats during 2007.

A total of 3,204 parasitic-phase sea lampreys was collected from 14 management districts; 265 were attached to lake trout and 2,939 were attached to Chinook salmon.

Parasitic-phase sea lampreys were attached at a rate of 1.62 per 100 lake trout (n = 16,379) and 1.41 per 100 Chinook salmon (n = 208,596).

A lake-wide mark-recapture study was initiated during the fall of 2004 using animals released as metamorphosing-phase juveniles. The releases were suspended in 2006 and resumed in 2007.

The recapture of spawning-phase sea lampreys released as metamorphosing juveniles during 2005 was completed. Of 750 metamorphosing sea lampreys marked with coded wire tags and released, 31 (4.1%) were recaptured as spawning adults in Lake Michigan during 2007. A total of 34,651 spawning-phase sea lampreys was scanned for coded wire tags in 16 Lake Michigan streams during 2007. The estimated abundance of the 2006 parasitic cohort is 813,238 (95% CI, 607,101-1,226,266).

A total of 756 metamorphosing sea lampreys was marked with coded wire tags and released into Lake Michigan tributaries during August – November, 2007 to estimate the 2008 parasitic-phase cohort (Cedar River – 73; Ford River – 73, Ogontz River – 72, Betsie River – 81, Jordan River – 72, Pere Marquette River – 158, Muskegon River – 227); fourteen sea lamprey died prior to release). Recapture of these sea lampreys as spawning-phase adults will take place during 2009.